

UNIVERSITY OF CALIFORNIA  
COLLEGE OF AGRICULTURE  
AGRICULTURAL EXPERIMENT STATION  
BERKELEY, CALIFORNIA

CIRCULAR 307

MAY, 1926

## AMERICAN FOULBROOD AND ITS CONTROL

G. H. VANSSELL

---

American foulbrood is the most serious disease known to apiculturists today and is responsible for large losses to the beekeeping industry. It is extremely infectious and much more destructive than European foulbrood, although its spread is usually not so rapid. Owing to the extreme longevity and resistance of the causative organism during the spore stage, the disease may be harbored in unsuspected ways and appear suddenly when least expected. This disease of the brood of bees is very often referred to simply as foulbrood. The name "American" has been applied to it to distinguish it from the other type of foulbrood, which is now spoken of as European foulbrood. Neither of these two diseases originated in this country, but both were prevalent among bees long before they were introduced to this hemisphere from the Old World. The name "American" is therefore inappropriate but is well established.

In all probability, the disease is of great antiquity. It was certainly known to Aristotle 2000 years ago, for he speaks of a disease of bees accompanied by a disgusting odor. Schirach in 1769 referred to this disease as did Dzierzon in 1882, but the definite cause was not known until White discovered the organism (*Bacillus larvae*) in 1904.

### *Seriousness of the Disease.*

Economical production of honey is not possible in an apiary where disease is rampant. The loss caused by the destruction of bees, combs, honey and hives in the earlier treatment of American foulbrood was so great that many beekeepers ceased operations because the decreased production was not met by a commensurate increase in the market price of honey.

### *Symptoms.*

When American foulbrood is present, its diagnosis is usually very definite because of the distinct character of the symptoms which is due to the fact that the bacteria causing this disease are generally the only organisms present and that they are putrefactive as well as pathogenic.

This disease most frequently kills the bee larvae in a late stage of development; in fact, in a fair percentage of the infections, death occurs after pupation has been almost completed. During the latter part of the larval period, the brood cell is sealed over or capped. The first indication of infection is a slight brownish discoloration of the normally white larva and the loss of the well rounded appearance.

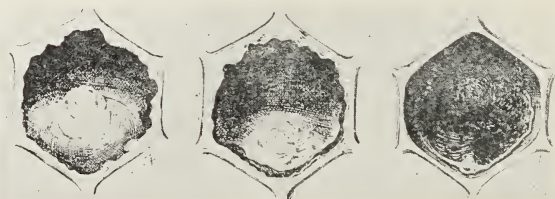


Fig. 1. Larvae dead from American foulbrood. The dead body settles down as it dries to form the adhering scale. (From U. S. D. A. Bulletin 809.)

The larva gradually sinks down in the cell, and becomes darker in color, until the posterior end rests against the bottom of the cell. (See fig. 1.) After the larva has partially dried and become dark brown (coffee colored), the most typical characteristic of the disease manifests itself. If a grass blade or other slender object is inserted into the mass and removed, the remains of the larva adhere to it and a thread of gummy substance may be drawn out to a varying distance. This "ropiness" is considered the final test by the beekeeper in the field. The larval remains continue to dry down until but a tightly adhering scale remains in the bottom of the cell. A characteristic odor is very noticeable with American foulbrood. It is usually spoken of as a "glue pot" odor, and once it becomes familiar to an observer, its presence is sufficient for recognition of this disease. Unfortunately the odor does not become pronounced until late in the development of the disease.

During the early stages of American foulbrood, the cappings over the infected larvae are indistinguishable from those that cover healthy larvae, but later they are often sunken and punctured. (See figs.

2, 3, 4.) Though this symptom is not peculiar to American foulbrood, it is an immediate indication that all is not well in the hive. Many of the cappings are later entirely removed by the bees and then the dried scales can be seen.

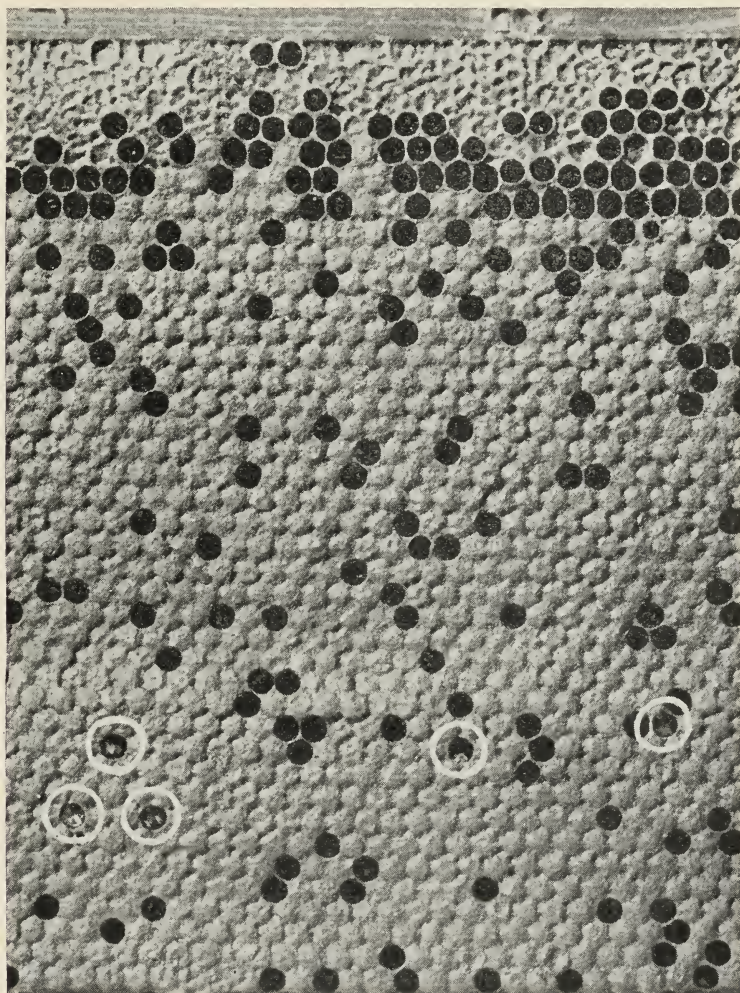


Fig. 2. How American foulbrood starts in the bee colony. The white circles indicate five cells in which the larvae are diseased. No other infected cells could be found in this hive at that time, June 10, 1919. (From Bulletin 333, Univ. Wis. Agr. Exp. Sta.)

Pupae may also be attacked by this disease and die, in which case they dry down through stages similar to those in the larvae. (See fig. 5.) The "tongue" of the pupa frequently adheres to the top of



the cell and may be observed after the drying is complete. Queen and drone brood are occasionally attacked as well as worker brood.

It sometimes happens that both European and American foulbroods are present in the same hive. When there is a question of uncertainty

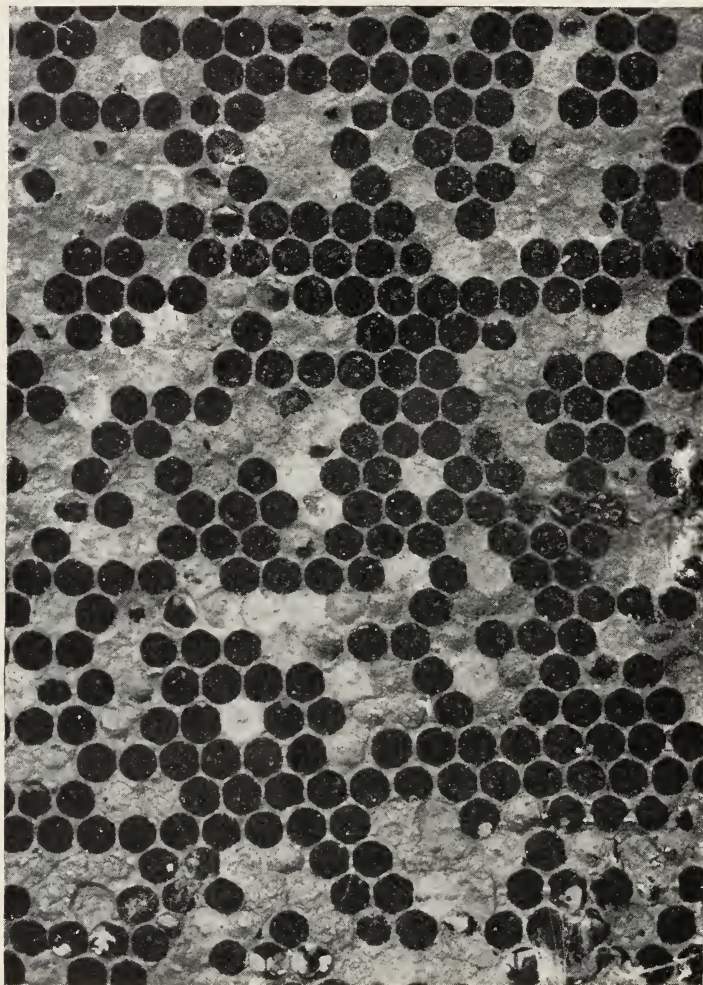


Fig. 3. Advanced stages of American foulbrood. This frame was removed from the hive shown in Fig. 2, July 20, 1919. (From Bulletin 333, Univ. Wis. Agr. Exp. Sta.)

as to the diagnosis, it is possible to obtain help in the matter. Samples of diseased brood in the comb, with no honey, can be sent through the mail. A wooden box such as a cigar box makes a good container.

The United States Department of Agriculture, Bureau of Entomology, Washington, D. C., or the Branch of the College of Agriculture, Davis, California, will examine material whenever it is sent in. There is no charge for this service.

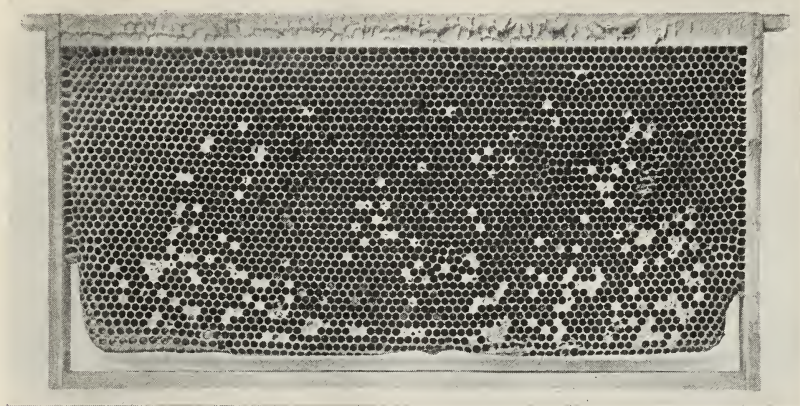


Fig. 4. Showing the scattered position of the sunken and punctured cappings in a rather advanced stage of infection. This frame was removed from the brood nest and all the healthy brood allowed to emerge before photographing.

### Cause.

The causative bacterium of American foulbrood is *Bacillus larvae* White. (See fig. 6.) It is a motile, spore-forming organism and like all bacteria multiplies very rapidly and its spores are of extreme

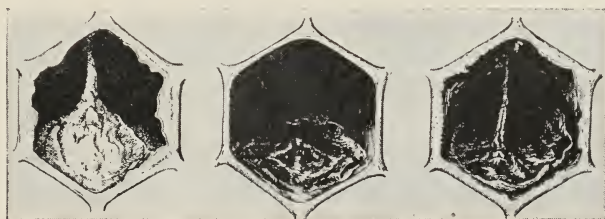


Fig. 5. Pupae dead from American foulbrood. The slender dried tongue adhering to the top of the cell is commonly observed and is a good character for diagnosis. (From U. S. D. A. Bulletin 809.)

longevity. Spores kept at room temperature have germinated after nine years, and infected combs have remained infective for fifteen years. The spores remain viable after exposure to boiling water for ten minutes. In honey this resistance is even more marked and it may be necessary to boil the honey for forty minutes to insure complete sterilization.

The spores of this organism are taken into the intestinal tract of the larva with its food, after which they germinate, grow, and give rise to the symptoms of the disease described above. The effect of the bacteria is gradual and the larvae die only after they have become well developed.

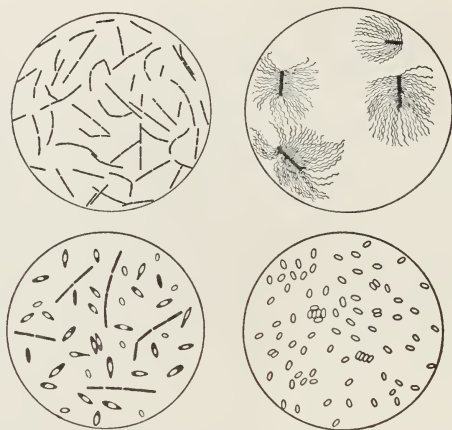


Fig. 6. Drawings of *Bacillus larvae*, the causative organism of American foulbrood, in its various stages of development. (From U. S. D. A. Bulletin 809.)

#### *Fundamental Facts Concerning American Foulbrood.*

1. The organism (*Bacillus larvae*) causing this disease forms spores.

2. These spores are so highly resistant to drying, sunlight, heat, and similar influences that they remain viable for years.

3. Honey containing these spores, when fed to healthy larvae, gives rise to a new infection. Thus, the robbing of one colony by another is a source of great danger.

4. It is very rare that an infection of American foulbrood disappears spontaneously, as is often the case with European foulbrood. This occurrence is so rare that it may be regarded as certain that once the organisms are introduced into a colony, they will cause its destruction and that of others in turn if careful attention is not given.

5. So far as known all races of bees are equally susceptible to American foulbrood.

6. The scales resulting from decomposed larvae adhere tightly to the cell wall and cannot be removed by the bees.

7. The use of spore-infected honey in making queen candy offers a fertile source for distributing this disease from one apiary to another.



8. There is no known method of treating a colony successfully without removing the bees from the infected material.

9. *Bacillus larvae* is not injurious to human beings.

### *Treatment.*

The older method of destroying the combs has now been supplanted so that it is possible to treat the infected combs economically. Dr. J. C. Hutzelman, with others, announced success through the use of an alcohol-formalin mixture. This solution is highly efficient and its cost low enough to permit thousands of gallons being used annually at present. However, a much cheaper water-soap-formalin solution, which can be mixed at home, has proved thoroughly satisfactory. The cost of the materials for this mixture averages about one-fifth that of the alcohol-formalin mixture. In comparative trials of efficiency, no distinct advantage was found which would justify the recommendation of one mixture over the other—both are good.

It has been held by some that a water-formalin mixture lacks in penetration power but the presence of the soap spreader increases this so that this criticism can no longer be justified. Also, the soap makes the mixture sufficiently alkaline to prevent precipitation of paraform from the formaldehyde, a process which would weaken the killing power of the mixture. Material of this type which was mixed in July, 1924, is still (May, 1926) being used satisfactorily.

### *Procedure.*

The bees are shaken from the infected colony into a clean hive with foundation. The usual precautions to prevent spreading the disease by robbing are observed. If possible, a hospital yard should be established at least two miles away from the apiary, where the colony should be moved before shaking.

The shaking treatment consists primarily in the removal of all infected material from the colony and in compelling the bees to take a fresh start by building new combs. All implements that will be needed, such as a hive tool, lighted smoker, drone trap, and queen cage should be in readiness before the operation is begun. The usual practice is to move the infected colony to one side, placing a clean hive with frames of foundation comb in its place. The bees are then shaken or brushed from the foulbrood combs in front of the clean hive. A spread newspaper will serve to catch the nectar which may fall from the combs. This paper should be burned after the job is completed to destroy this source of danger. An extra bee-tight hive-body with top and bottom should be used to receive the frames, from

which the bees have been dislodged. After the queen and most of the bees are in the new hive, a queen and drone trap or a strip of perforated zinc should be placed over the entrance to prevent the colony from deserting. Shaking at sundown after the field flight stops will reduce the robbing danger greatly.

If several colonies are being treated at one time, it may pay to stack the several hive-bodies containing contaminated combs over a diseased colony, allowing most of the healthy brood to emerge. One populous colony results from this since all the emerging young bees take up the work of the one group. After two weeks this colony is treated in turn and all the combs sterilized.

Some beekeepers prefer to shake the bees first on to frames containing only strips of foundation comb (rather than on full sheets) and after four days to shake the colony a second time on to full sheets of foundation or drawn combs.

If little or no nectar is coming in the bees must be fed after 48 hours. This stimulative feeding will be of great help to the bees even when nectar is available. If clean, drawn or treated combs are on hand, they may be given to the shaken colony after 48 hours. This part of the treatment is different in no way from the common practice in use when the infected combs are burned or rendered for wax.\*

Hive-bodies and hive parts from diseased colonies should be thoroughly scraped and cleaned before being used again on clean colonies, because the hive parts are almost sure to become more or less smeared with infective honey during the period of treatment. A thorough scrubbing with a cloth and running water to remove all traces of honey from all hive parts will materially assist in reducing the spread of American foulbrood. Many beekeepers, in addition to washing, scorch out the hive bodies *slightly*; others dip them in the sterilizing solution. Both these practices are good precautionary measures, as is also the painting of the cleanly scraped bodies as well as the tops and the bottoms.

### *Method of Comb Treatment.*

The process of handling and treating the infected combs and materials is as follows:

1. *All cells* (both brood and honey) are *uncapped*† and the honey from them is thrown out by means of an extractor. (This honey of

---

\* See U. S. Dept. Agr. Farmers' Bulletin no. 1084 for detailed particulars on the shaking treatment for American foulbrood.

† If the sealed brood cells are not opened in uncapping, they should be punctured by scratching with a steel brush, curry comb, or similar tool.



course must be handled with great care and must not be fed back to bees unless boiled for forty minutes.)

2. The remaining honey is removed from the combs by placing in a vat and soaking twelve hours in water.

3. The "honey-dissolving" water is thrown from the cells by running the combs through the extractor.

4. The empty wet combs are returned to the dipping vat. The method of filling the comb vat with the sterilizing solution is shown in figure 7, *a* and *b*. By means of a hoisting tackle, the solution keg

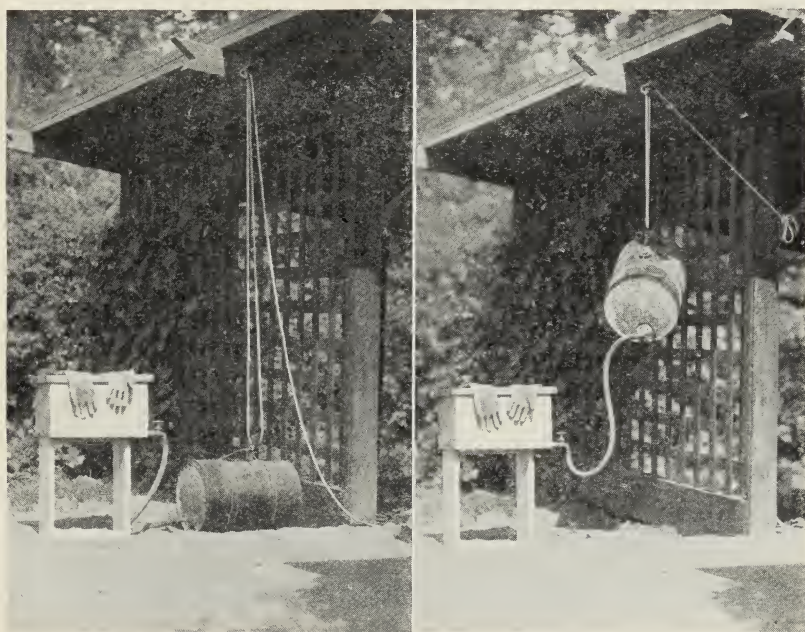


Fig. 7. (*a*) An arrangement for filling the comb vat. The frames are placed in position for sterilization before the keg is hoisted. (*b*) Showing use of block and tackle for hoisting the keg containing the sterilizer. The solution flows slowly through the three-fourths inch hose, thereby filling every cell in the combs.

is raised above the level of the top of the vat. The keg is connected with the vat by a three-fourths inch hose with valves for regulating the flow, allowing the solution to flow into and fill each cell as the level *slowly* rises.

When the vat is full and all the combs covered, the valve is closed and the keg lowered to the floor. At the end of the immersion period the valve is opened to permit the solution to flow back into the keg. The vat should be kept covered to prevent evaporation. Since the sterilizer gives off formalin vapor, which is irritating to mucous

membranes, it is best to have the equipment in an open screened structure to allow the wind to carry the vapors away. Also rubber gloves should be worn when handling combs wet with the solution.

5. After forty-eight hours the solution is drawn off, and that remaining in the cells is thrown from the combs with an extractor and saved for re-use.

6. The combs are thoroughly dried and aired\* for several days, after which they are ready for use wherever they may be needed.

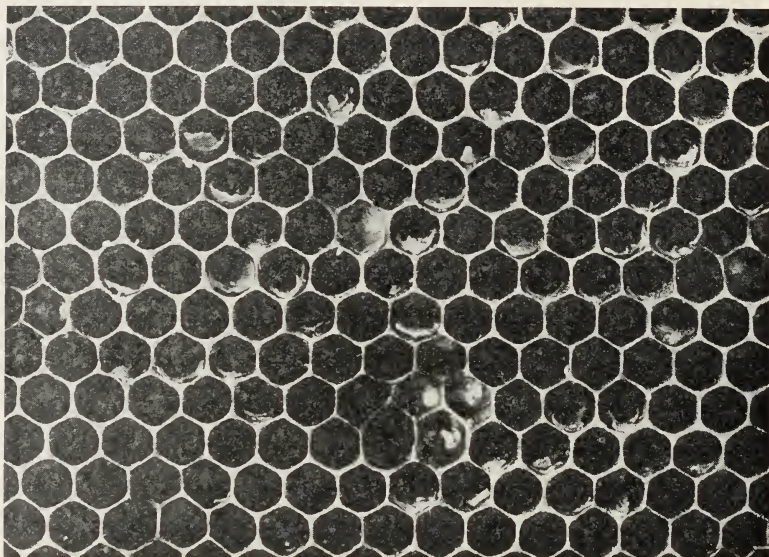


Fig. 8. The dried adhering scales from larvae dead from American foulbrood are loosened by the water-soap-formalin. The bees readily remove the loosened scales, and carry them out of the hive.

### *The Solution.*

The water-soap-formalin mixture contains the following:

Water (soft preferably)	4 quarts
Liquid soap.....	2 ounces
Formalin .....	1 quart

The liquid soap is simply poured into the water. This kind of soap is recommended because it is readily miscible with water. The

---

\* The bees are a little slow in cleaning out the combs if the airing is not given. It takes much more time for the old scales to be removed (see figs. 8 and 9) and the cells polished for laying purposes than for honey storage. The bees will prepare the combs during the periods of little flow and should be put to this work long in advance of the main flows.



formalin is then poured in and the mixture stirred. If it is necessary to use hard water, a little more soap should be used since some of it is precipitated by the chemicals in the water.

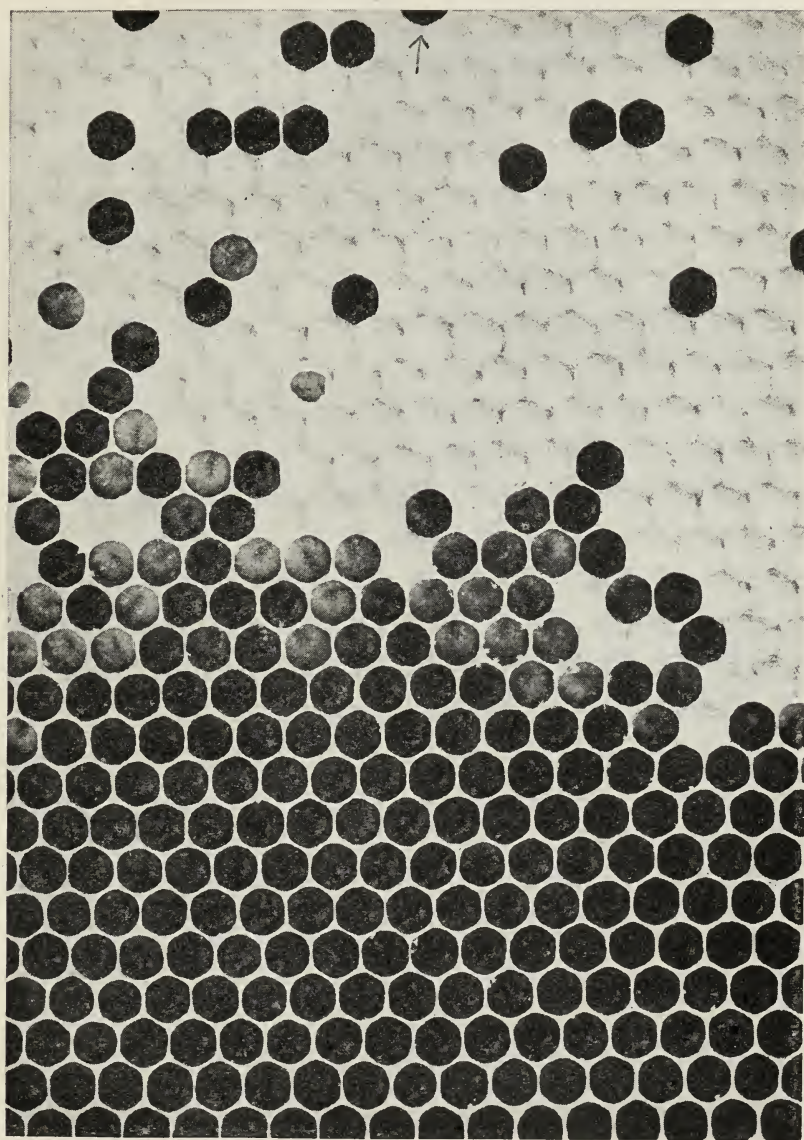


Fig. 9. Healthy brood in all stages being reared in American foulbrood combs that have been treated with the water-soap-formalin solution.



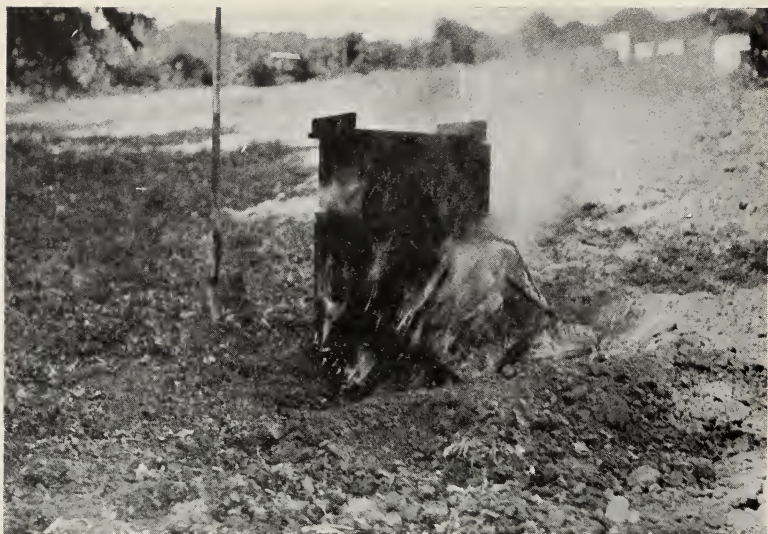


Fig. 10. The old method of treatment with fire. This is still useful where but few colonies are infected.

#### SUMMARY

American foulbrood is a bee disease which is causing great losses to beekeepers. It has been in America almost since the hive bee was introduced and has been known to beekeepers since time immemorial.

American foulbrood is caused by a spore-forming bacterium, *Bacillus larvae*. In its control it is necessary to know the symptoms thoroughly in order to be able to differentiate between this and European foulbrood, because the two do not require or respond to the same treatment. All combs, honey, and other material must be removed from the colony, giving the bees a chance to reestablish themselves in the new combs.

It is no longer necessary to destroy the infected combs. They can be economically sterilized with a solution of water, soap, and formalin by following the methods outlined in this circular.

#### ACKNOWLEDGMENTS

Several beekeepers have tried this treatment in their apiaries and all have reported favorably. The major part of the culturing, in connection with sterility tests, was done by N. Fiat, a graduate student, under the direction of Dr. C. S. Mudge of the University of California. Doctors T. I. Storer and S. B. Freeborn have made many helpful suggestions in the preparation of the manuscript. This opportunity is taken to express my appreciation.